APR 1 8 2001
PATENT & TRADEMARK OFFICE

ANTI-MICROBIAL STERILIZER AND REFRIGERATOR HAVING ANTI-MICROBIAL STERILIZER

Technical Field

[0001] The present invention relates to an anti-microbial sterilizer having an antibacterial-sterilizing function used in a refrigerator and a refrigerator equipped with the sterilizer.

Background Art

[0002] Refrigerators successfully generate low-temperature preservative environmental conditions therein for reducing the growth of microbial spores but fail to provide a favorable sterilizing effect of destroying living microorganisms and bacteria. One sterilizer is implemented by mixing and impregnating an anti-microbial agent with a resin as disclosed in Japanese Patent Laid-open Publication 8-210761.

[0003] Such a conventional sterilizer used in a refrigerator will now be explained referring to the relevant drawing.

[0004] Fig. 8 is a cross sectional view of the refrigerator. As shown, the refrigerator has a housing 1 made of a heat insulating material 2 and comprising a refrigerating chamber 5 at an upper location, a freezing chamber 6 at intermediate location, and a vegetable chamber 7 at a lower location which are separated by two partitions 3 and 4. A blower 9 is provided for forcing, into each chamber, a flow of chilled air generated by a cooler 8 in a refrigerating circuit. A compressor 10 is mounted in the bottom of the housing 1.

[0005] A chilled-air output duct 11 is provided for distributing the chilled air generated in the cooler 8 into the refrigerating chamber 5 by the blower 9. A container 12, which is made of resin material, is installed in the vegetable cooling chamber 7 and particularly, is doped with silver-based anti-microbial agent (not shown).

[0006] According to the above arrangement, any microbes contacting the container 12 may be inhibited from growing by the sterilizing action of the anti-microbial agent doped in the resin material.

[0007] The conventional sterilizer, however, fails to destroy most microbes floating in the air or attached on foods, and exhibits a relatively lower sterilization effect in actual use.

[0008] Also, the conventional sterilizer has no function for increasing the preservability of foods including their nutrients.

Summary of the Invention

[0009] The present invention provides a sterilizer exhibiting a practically higher sterilization effect including preservation of foods without directly contacting them, and provides a refrigerator equipped with the sterilizer.

[0010] The sterilizer according to the present invention comprises:

(a) an air-permeable capsule encapsulating an anti-microbial material therein which has a base ingredient impregnated with a volatile anti-microbial agent;

(b) a less-permeable container having ventilation apertures provided partially thereon for accommodating the capsule; and

(c) a peelable, less-permeable film provided for sealing the ventilation apertures on the container. In action, when the film is removed from the container, a vapor of the anti-microbial agent emitted from the anti-microbial material in the capsule can run through the ventilation apertures of the container and flow into the external atmosphere.

[0011] Accordingly, the surface of foods as well as the air are exposed to and sterilized by the vapor, and the nutrients of the foods can thus be preserved.

[0012] A refrigerator according to the present invention has the sterilizer mounted in a passage of the chilled air. This arrangement can improve the sterilization effect of the surface of foods as well as the air in the refrigerator.

[0013] Another refrigerator according to the present invention has the sterilizer mounted in a chamber thereof. This can improve the sterilization effect of vegetables stored in the chamber and the preservation of the nutrients of any stored food.

Brief Description of the Drawings

[0014] Fig. 1 is a cross sectional view of a sterilizer according to Embodiment 1 of the present invention;

[0015] Fig. 2 is a plan view of a capsule in a sterilizer according to Embodiment 2 of the present invention;

[0016] Fig. 3 is a cross sectional view of a sterilizer according to Embodiment 3 of the present invention;

[0017] Fig. 4 is a cross sectional view of a sterilizer according to Embodiment 4 of the present invention;

[0018] Fig. 5 is a cross sectional view of a sterilizer according to Embodiment 6 of the present invention;

[0019] Fig. 6 is a cross sectional view of a refrigerator equipped with a sterilizer according to Embodiment 7 of the present invention;

[0020] Fig. 7 is a cross sectional view of a refrigerator equipped with a sterilizer according to Embodiment 8 of the present invention; and

[0021] Fig. 8 is a cross sectional view of a conventional refrigerator.

Detailed Description of the Invention

[0022] A sterilizer and a refrigerator according to embodiments of the present invention will be described referring to the accompanied drawings. Like components are denoted by like numerals as those explained with the prior art and will be described in no more detail.

(Embodiment 1)

[0023] Fig. 1 is a cross sectional view of a sterilizer according to Embodiment 1 of the present invention.

[0024] A sterilizer 13 comprises a container 14, a cover 15 closing the upper opening of the container 14, and a capsule 16 installed in the container 14. The capsule 16 is filled with an anti-microbial material 17 which is made of a volatile anti-microbial agent 19 impregnated in a base material 18.

[0025] The capsule 16 has two ends welded together to form a double seal for encapsulating the anti-microbial material 17 therein. The capsule 16 is accommodated in the container 14 and distanced by a space 20 from the cover 15.

[0026] The anti-microbial agent 19 may be selected from aliphatic esters and aromatic esters like ester isothiocyanate, and more preferably, allyl isothiocyanate for providing higher effects of anti-microbial property and food preservability. The base material 18 may be natural resins, porous powder substances, viscous substances, paper, and unwoven fabrics. Preferably, the base material 18 is rosin ester, which is capable of holding and gradually emitting the allyl isothiocyanate and is high in physical stability and safety.

[0027] The capsule 16 is made of an air-permeable film adapted and shaped for allowing the allyl isothiocyanate, the anti-microbial agent 19, in the anti-microbial material 17 to be emitted as vapor. More particularly, the film may have a multiplicity of tiny apertures through which the allyl isothiocyanate in vapor is emitted. Alternatively, the film may be highly breathable for the evaporated allyl isothiocyanate. This permits the allyl isothiocyanate, the anti-microbial agent 19, to be emitted at a proper concentration. The material of the capsule 16 may be a combination of unwoven fabric and air-permeable film such as polyethylene or polypropylene film bonded together.

[0028] The cover 15 has ventilation apertures 21 provided thereon passing the vapor of the anti-microbial agent 19. A peelable, less-permeable film 22 is welded to the upper end

including the opening of the container 14 to hang over the ventilation apertures 21. The film 22 may be made of an aluminum foil or an aluminum-evaporated film.

[0029] Table 1 illustrates a result of testing the anti-microbial effect of the sterilizer. The test is conducted with spores of microbes suspended in a box of 50cm in length, 50cm in width, and 50cm in height. Then, two conditions are developed. One is that the box is impregnated with a silver-based anti-microbial agent, which is thus applied to the inner wall of the box, and another is that the box is filled with a given concentration of the allyl isothiocyanate. The spores of microbes in the air are sampled using filters before and after the beginning of the test, cultured, and then, counted as colonies. As a result, the sterilizer of the embodiment exhibits one hundred times as high an anti-microbial effect (spore reduction) as the conventional sterilizer, which exhibits much improvement.

(Table 1)

	Conventional	Embodiment
Number of Spores before Test (Numbers / L)	2.0×10^4	2.0×10^4
Number of spores after Test (Numbers / L)	2.0×10^3	10
Spore Reduction	1/10	1/1000

[0030] As seen from the results in the table, the sterilizer 17 of this embodiment emits the anti-microbial agent 19 of allyl isothiocyanate filled in the capsule 16 through the ventilation apertures 21 into an external atmosphere when the less-permeable film 22 has been removed.

[0031] The anti-microbial agent 19 inhibits microbes floating in the air or attached to the surface of foods from growing and thus exhibits a higher sterilization effect than the conventional one even without a direct contact.

[0032] Also, attenuating ethylene and minimizing the decomposition of Vitamin C by allyl isothiocyanae enlarge the preservation of foods, particularly vegetables and fruits, through protecting their nutrients and inhibiting them from degrading with age.

[0033] Since the opening of the container 14 is sealed closely with the less-permeable film 22 before its usage, the anti-microbial agent 19 does not leak. Therefore, the sterilizer 13 can instantly exhibit its sterilizing effect with ease just upon the film 22 being removed.

[0034] The space 20 between the capsule 16 and the cover 15 avoids any stress or pressure from directly being exerted on the capsule 16 when the cover 15 is welded to seal the container 14. This allows the base material 18 encapsulating the anti-microbial agent 19 from leaking out, hence increasing the reliability of the sterilizer 13.

(Embodiment 2)

[0035] Fig. 2 is a plan view of the capsule in a sterilizer according to Embodiment 2 of the present invention. A capsule 23 is a roll of a thermally-bonded air-permeable film of unwoven fabric thermally-sealed at both ends by double-sealing of a first seal 24 and a second seal 25. It is filled with an anti-microbial material 17.

[0036] The capsule 23 is thermally-sealed in a manner corresponding to the material thereof. In this embodiment, the first seal 24 is double-sealed at a sealing temperature of 135°C and under a pressure of 4kgf/cm^2 while the second seal 25 is welded at a sealing temperature of 120°C and under a pressure of 1kgf/cm^2.

[0037] In action, when the anti-microbial material 17 is liquid or has a lower viscosity, it may undesirably leak out from both ends of the capsule 23. However, the double-sealing at each end positively prevents the anti-microbial material 17 from leaking out, hence increasing the reliability of the sterilizer.

(Embodiment 3)

[0038] Fig. 3 is a cross sectional view of a sterilizer according to Embodiment 3 of the present invention.

[0039] A sterilizer 26 has an anti-microbial material 27 encapsulated in a capsule 16. A base material 28 is a mixture of a liquid or low viscous material and an additive 29 which is a lower temperature thermoset. The anti-microbial material 27 includes the base material 28 impregnated with a volatile anti-microbial agent 19. The additive 29 may preferably be a paraffin wax for safety and stability.

[0040] Even when the base material 28 of the anti-microbial material 27 is liquid or has a lower viscosity, the impregnated additive 29, which is a lower temperature thermoset, can guarantee a desired viscosity of the anti-microbial material 27. Accordingly, the anti-microbial material 27 stays in a solid form or a non-fluid gel form at an ordinary temperature and can thus be prevented from leaking out from the capsule 16, hence improving the handling of the sterilizer.

EP 0 952 769 A2

(Embodiment 4)

[0041] Fig. 4 is a cross sectional view of a sterilizer according to Embodiment 4 of the present invention.

[0042] As shown in Fig. 4, a sterilizer 30 has an anti-microbial material 31 encapsulated in a capsule 16. A base material 32 of the anti-microbial material 31 is doped with an additive 29, e.g., a paraffin wax, which is a lower temperature thermoset. The anti-microbial material 31 also includes a volatile anti-microbial agent 19 and a volatile aromatic substance 33. The aromatic substance 33 may preferably be selected from a variety of herbs having a function of masking irritating odors of the anti-microbial agent 19. More preferably, the aromatic substance 33 may be peppermint oil, which exhibits a synergistic sterilization effect together with allyl isothiocyanate. Also, a space 34 is provided between a film 22 and a cover 15 for the anti-microbial material 31.

[0043] The space 34 above the anti-microbial material 31 including the anti-microbial agent 19 and the aromatic substance 33 can hold the aromatic substance 33, which is lower in the volatility than the anti-microbial agent 19, at a high gaseous saturation. Accordingly, the odors of allyl isothiocyanate generated when the less-permeable film 22 is removed can be diminished by the masking effect of peppermint oil, the aromatic substance 33. Also, the allyl isothiocyanate and the peppermint oil in a combination can exhibit a synergistic effect for improving the sterilization.

(Embodiment 5)

[0044] Table 2 illustrates a composition of a sterilizer according to Embodiment 5 of the present invention.

[0045] An aromatic substance 33 is contained in an anti-microbial material 31 at a higher concentration than an anti-microbial agent 19 in the material 31.

[0046] Also, the ratio of peppermint oil to allyl isothiocyanate is increased for masking irritating odors of the highly volatile allyl isothiocyanate. This allows the low volatile peppermint oil to mask the highly volatile allyl isothiocyanate thus minimizing the odors of allyl isothiocyanate. Moreover, the peppermint oil and the allyl isothiocyanate in a combination can exhibit a synergistic effect for the sterilization.

(Table 2)

Components	Content (wt. %)
Allyl Isothiocyanate	15.6
Peppermint Oil	19.6
Rosin Ester	54.5
Paraffin Wax	10.4

(Embodiment 6)

[0047] Fig. 5 is a cross sectional view of a sterilizer according to Embodiment 6 of the present invention. A sterilizer 35 has an anti-microbial material 36 encapsulated in a capsule 16. A second aromatic substance 37 is different than the first volatile aromatic substance 33. While the first volatile aromatic substance 33 is an herb type such as peppermint oil, the second aromatic substance 37 is a citrus type such as a lemon extract. Accordingly, the anti-microbial material 36 contains two, herb and citrus, different aromatic substances 33 and 37.

[0048] For enhancing the sterilization effect, the ratio of the anti-microbial agent 19 such as allyl isothiocyanate, which generates irritating odors needs to be increased. Although a larger amount of odors is emitted from the anti-microbial agent 19, a combination of the herb aromatic substance 33, peppermint oil, and the citrus aromatic substance 37, lemon extract, successfully mask the odors.

[0049] For masking more odors from the anti-microbial agent 19 by one type of aromatic substance, the herb aromatic substance 33 has two increases. The effect of the increase in aromatic substance 33 for masking the odors may accordingly saturate, or the scent of the aromatic substance 33 itself may accordingly turn to an odor discouraging users.

[0050] As the two different aromatic substances 33 and 37 are mixed up, they cooperate to favorably mask the odors released from the anti-microbial agent 19 without emphasizing the scent of the original aromatic substance 33. The extra aromatic substance 37 is a type of citrus, and the scent can soften the atmosphere for masking the odors with the counter scent of the herb aromatic substance 33. Also, the aromatic substance 37 of a citrus type, e.g., a lemon extract, has a sterilization effect and can contribute to the synergistic effect of sterilization.

(Embodiment 7)

[0051] Fig. 6 is a cross sectional view of a refrigerator according to Embodiment 7 of the present invention. A refrigerator 38 has a sterilizer 30 mounted at an appropriate location in a chilled-air-output duct 11 thereof.

[0052] In action, the chilled air produced by a cooler 8 is conveyed by a blower 9 through the chilled-air-output duct 11 into a refrigerating chamber 5 for refrigeration. While the chilled air conveyed in the chilled-air-output duct 11 runs through the sterilizer 30, an anti-microbial agent 19, e.g., allyl isothiocyanate, and an aromatic substance 33, e.g., peppermint oil, are distributed in an evaporated form into the refrigerating chamber 5. The anti-microbial agent 19 and the aromatic substance 33 are then conveyed from the refrigerating chamber 5 via a circulating passage of the chilled air into a freezing chamber 6 and a vegetable cooling chamber 7. Any microbes floating in the air and attached on foods in the refrigerator 38 are exposed to the chilled air and sterilized by the anti-microbial agent 19. Simultaneously, the aromatic substance 33 reduces irritating odors of the anti-microbial agent 19. This allows a user to be free from the odors when opening the door of the refrigerator 38.

[0053] The sterilizer 30 according to this embodiment is located in the chilled-air output duct 11. If it is unfavorable to be under a lower temperature, the sterilizer 30 may be mounted in a chilled-air input duct. Alternatively, the sterilizer 30 may be located not in the duct but at any possible location where the chilled air runs.

(Embodiment 8)

[0054] Fig. 7 is a cross sectional view of a refrigerator according to Embodiment 8 of the present invention. A vegetable cooling chamber 40 is separately provided in a refrigerator housing 39. A sterilizer 30 is mounted at the back top of a container 12.

[0055] In action, the inner space of the vegetable cooling chamber 40 is filled with an evaporated anti-microbial agent 19, e.g., allyl isothiocyanate, and an aromatic substance 33,

e.g., peppermint oil, both of which are emitted from the sterilizer 30. The anti-microbial agent 19 and the aromatic substance 33 dissipating in substantially a closed space of the vegetable cooling chamber exhibit a higher sterilization effect for destroying microbes floating in the air and attached on foods, such as vegetables and fruits, in the vegetable cooling chamber. Also, an effect of minimizing ethylene gas and the decomposition of Vitamin C by the allyl isothiocyanate prevent vegetables and fruits from decaying, and their nutrients can successfully be preserved. Furthermore, the odor of the anti-microbial agent 19 is reduced by the masking effect of the aromatic substance 33 and thus hardly disturb the user when opening the door of the refrigerator.

[0056] The sterilizer 30 according to this embodiment is located in the vegetable cooling chamber 40. However, it may also be mounted with an equal effect in any compartment or container which is not dedicated to but assigned for storing vegetables and fruits in the refrigerator.

[0057] Table 3 illustrates results of a test of the sterilization effect in the vegetable cooling chamber of the refrigerator according to this embodiment. The test was conducted with two different conditions, including a first one where the vegetable cooling chamber was protected with a conventional silver-based anti-microbial agent, and a second one with the sterilizer of this embodiment. In each condition, the vegetable cooling chamber is filled with a pack of strawberries. The pack contains a mold-grown strawberry in the center thereof. The growth of the mold with time is then monitored. As a result, the conventional condition exhibits the growth of mold on neighbor strawberries, and the condition according to this embodiment does not exhibit that. That is, the sterilization effect of the sterilizer according to this embodiment is higher than that of the conventional one.

(Table 3)

	Conventional	This Embodiment
Growth of Mold before Test	-	-
Growth of Mold after Test	+++	-

Note) -: No growth, +++: Significant growth

Industrial Applicability

[0058] The present invention relates to an anti-microbial sterilizer having an antibacterial-sterilizing function used in a refrigerator, and a refrigerator equipped with the sterilizer. The sterilizer according to the present invention comprises an anti-microbial material having a base ingredient impregnated with a volatile anti-microbial agent, an air-permeable capsule encapsulating the anti-microbial material, a less-permeable container having ventilation apertures provided partially thereon for accommodating the capsule, and a peelable, less-permeable film provided on the container at the ventilation apertures. In action, the anti-microbial agent released into an external atmosphere can destroy any microbes floating in the air and attached on foods and inhibit their spores from growing.

[0059] In a refrigerator having the sterilizer mounted in a passage of chilled air, the anti-microbial agent emitted from the sterilizer is conveyed throughout the refrigerator with the flow of the chilled air. The sterilizing effect can kill any microbes floating in the air and attached on foods.

[0060] Also in a refrigerator having the sterilizer mounted in a chamber thereof where vegetables are stored, the anti-microbial agent emitted from the sterilizer is conveyed throughout the chamber. The sterilizing effect can kill any microbes floating in the air and

attached on foods, and can reduce ethylene gas and the loss of nutrients including Vitamin C from vegetables and fruits.

[0061] Moreover, the anti-microbial material may be doped with an aromatic substance. The aromatic substance masks the anti-microbial agent and thus reduces irritating odors of the agent in the refrigerator.

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